Evaluation of the Surface Water Withdrawals from the Kissimmee Chain of Lakes

AFET Model Performance under the Original and Revised PET Data Sets Technical Memorandum Deliverable B.2.1.1.a

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1 INTRODUCTION

The South Florida Water Management District (SFWMD) has revised the potential evapotranspiration (PET) dataset to be used in the Kissimmee Basin Modeling and Operations Study (KBMOS). The original PET dataset was used in the calibration and verification process and in the evaluation of base conditions. The new dataset is to be used in calibrating the Alternative Formulation Evaluation Tool for Water Supply (AFET-W) model. Prior to the development of the AFET-W model, which is a revision of the original Alternative Formulation Evaluation Tool (AFET) model, the revised dataset was input to the model and the results were analyzed to determine differences that may have resulted from the revised PET dataset. The AFET model verification period was 1994 to 1998. The period from 1995 to 1998 will be used for the calibration of the AFET-W model. However, since results were presented for the 1994 to 1998 period in the AFET report, this same period was used to test if there were differences resulting from the revised PET dataset.

2 REVISION OF POTENTIAL EVAPOTRANSPIRATION DATA

The original PET dataset in the model was a dfs0 file consisting of a single time series of data that represented the entire model domain. The revised PET dataset was provided by the SFWMD as a separate time series for individual cells throughout the model domain. This file was used to create a dfs2 file that contained spatially a varied time series for each of the 1,000 x 1,000 foot grids of the model domain. An evaluation was completed first by comparing the data and second, by comparing the results of the models.

2.1 Comparison of Dataset

Since the data consisted of one time series for the original PET dataset and multiple time series for the revised PET dataset, time series data for a point in the approximate centroid of the model domain was extracted from the revised model to compare with the original model. It was assumed that the point at the centroid is representative of the model domain. The plot below shows the data.

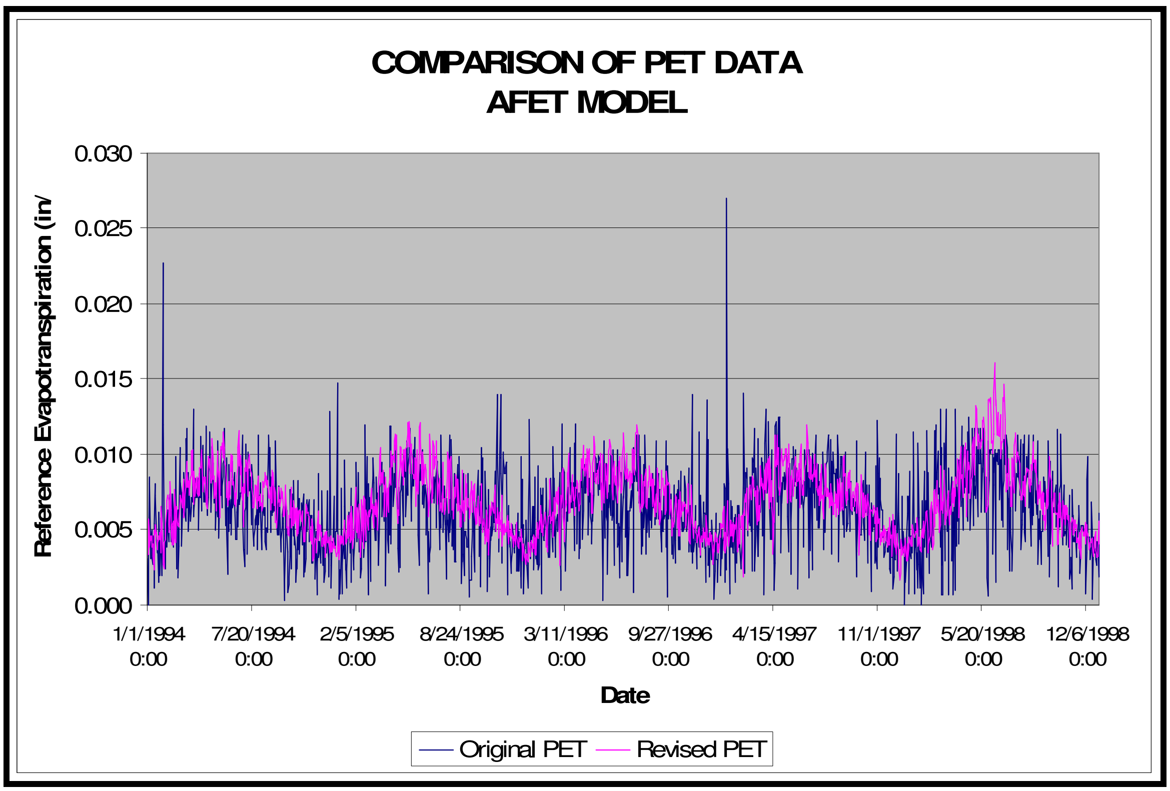

Figure 2-1: Comparison of PET Data

In comparing the data shown above, it was noted that the revised data and original data both track the same general pattern, but the original data were much more sporadic with more pronounced deviations. In addition to the graphical comparison, statistics were extracted and are presented in Table 2-1.

Table 2-1: PET Statistics

Statistic	Original PET in/hr	Revised PET in/hr
Mean	0.0063	0.0069
Maximum	0.0270	0.0168
Minimum	0.0000	0.0014
Standard Deviation	0.0027	0.0021

The statistics show that overall, the revised PET dataset was slightly higher (110 percent of original) at the point of comparison. However, the revised PET dataset had a lower maximum and lower standard deviation.

2.2 Comparison of Results

Water Balance

Both models were run for the period from 1994 to 1998 and results were compared. Water balances for both models are shown in Figure 2-2 and Figure 2-3.

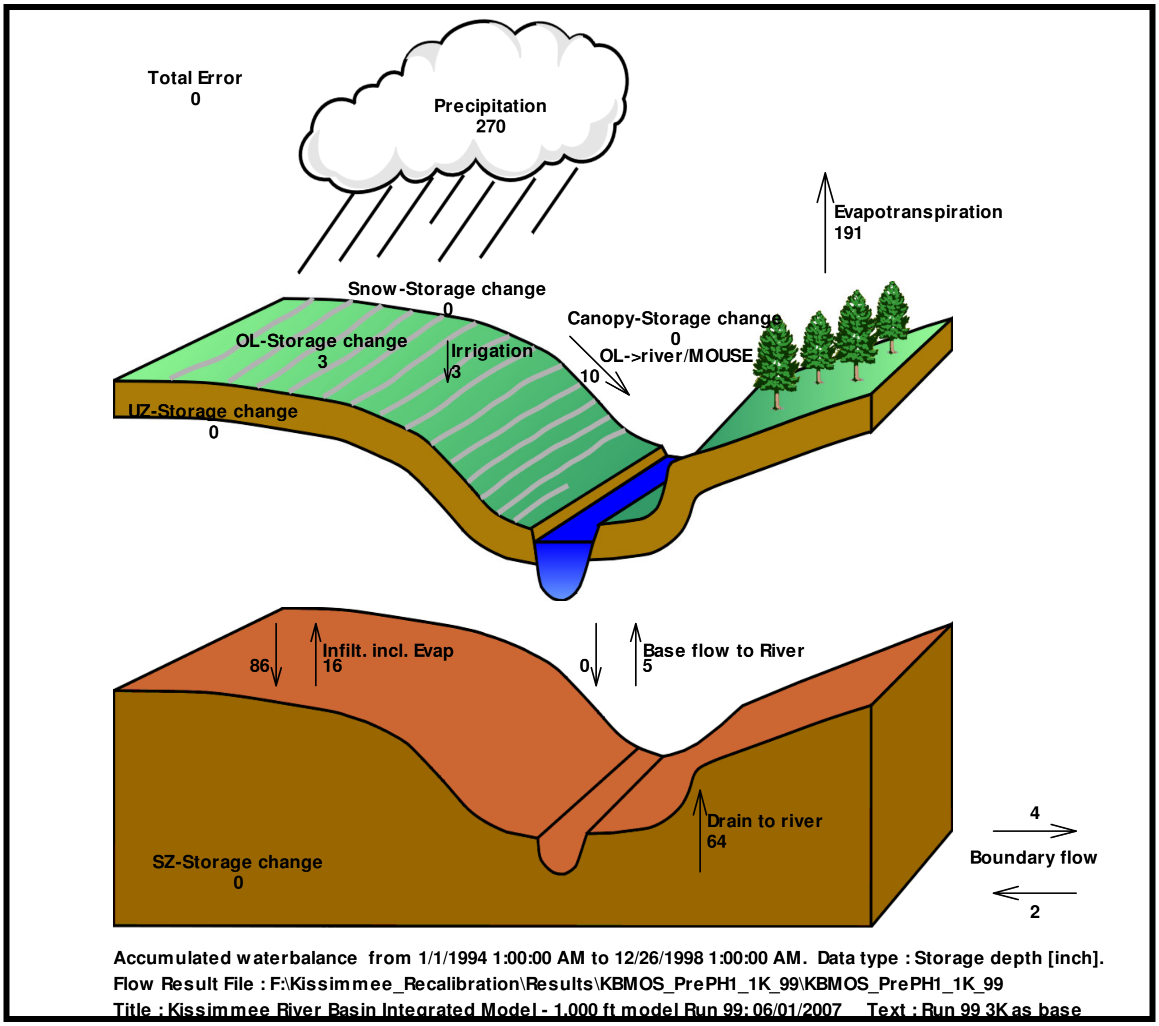

Figure 2-2: Water Balance for Original PET Model

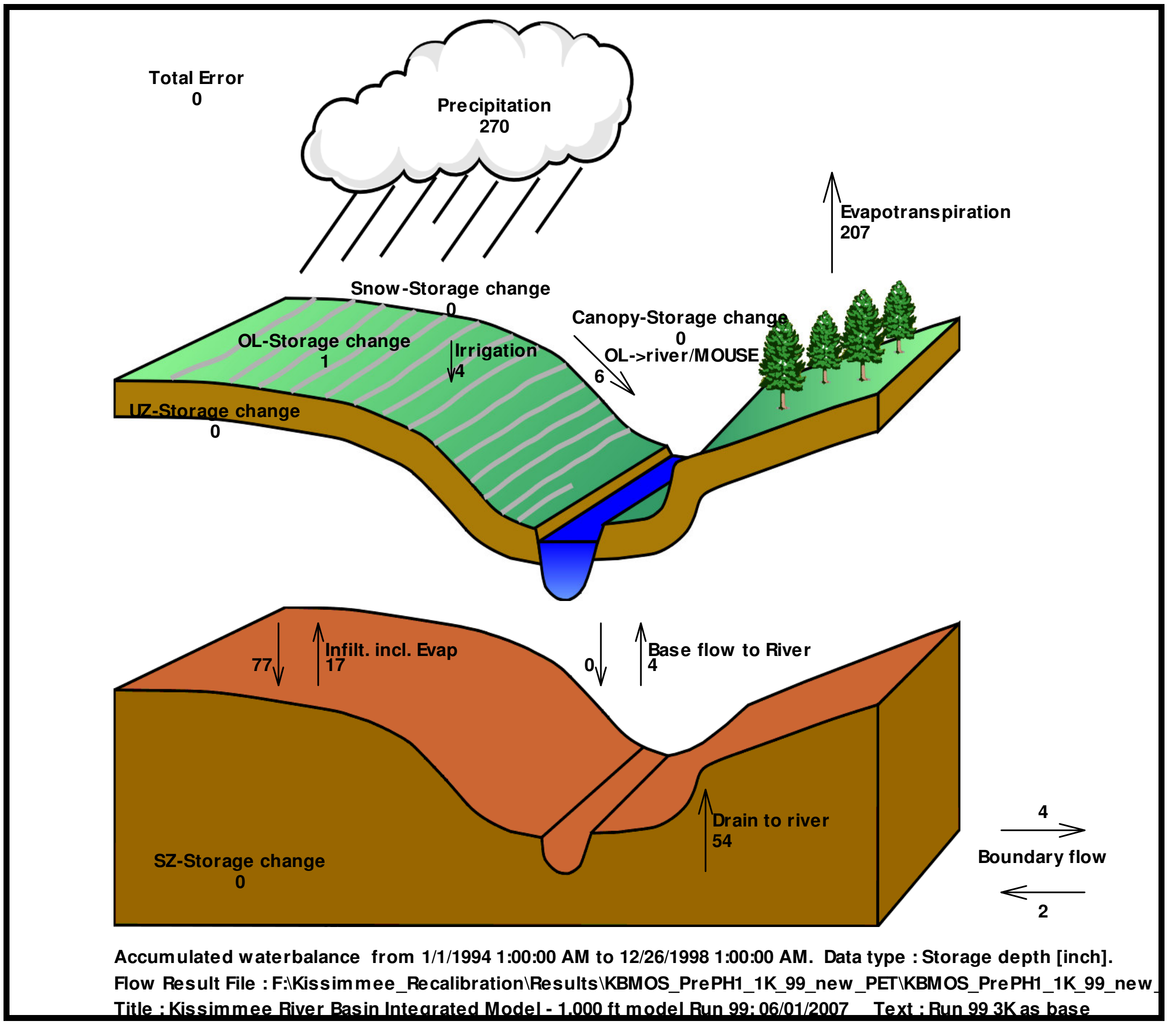

Figure 2-3: Water Balance for Revised PET Model

Table 2-2 is a comparison of results to show the change in allocation when the revised PET dataset was applied. The first obvious change is the change in evapotranspiration where the revised model increased by 16 inches over a five-year period (3.2 inches per year). Because of this, less water was available for overland storage so that 2 inches less (0.4 inches per year) was stored in the same five-year period. Similarly, the higher evapotranspiration slightly increased the irrigation demand. The most significant result of the increased evapotranspiration was that infiltration was reduced by nine inches and consequently, 10 inches less of this infiltrated water drained back to the river.

Table 2-2: Water Balance Changes

	Original PET	Revised PET	Change
Precipitation	270	270	0
Evapotranspiration	191	207	+16
Overland Storage Change	3	1	-2
Irrigation	3	4	+1

UZ Storage Change	0	0	0
SZ Storage Change	0	0	0
Canopy Storage change	0	0	0
Infiltration	86	77	-9
Evaporation	16	17	+1
Base flow to River	5	4	-1
Drain to River	64	54	-10
Net Boundary Flow	-2	-2	0

Overland Flow

Overland flow was assessed by comparing original PET overland flow maps with that of the revised PET dataset. This comparison was made by calculating difference maps (original minus revised PET dataset) to correspond with the following maps presented in the KBMOS AFET Calibration Report.

1. Figure 5.89 Maximum overland flow depths for the 1996 wet period
2. Figure 5.90 Maximum overland flow depths for the 1996 to 1997 dry period
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8. Figure 5.96 Average overland flow depth for the 1997 to 1998 dry period
9. Figure 5.97 Percent of time overland flow depths exceed 1 inch during the verification period (now calibration period)
10. Figure 5.98 Percent of time overland flow depths exceed 1 foot during the verification period (now calibration period)

These maps are presented in Appendix A. In examining the difference maps, it was determined that differences were minimal in most instances, but in general, there was a decrease in overland flow depth.

Surface Water

Surface water statistics for both models were compared to determine if the calibration improved because of the new PET data. The comparison is shown in Table 2-3 and Table 2-4.

Table 2-3: Surface Water Stage Statistics

MODEL AREA	Station	RMSE Original	R(correlation) Original	RMSE New PET	R(correlation) New PET
Stages in Upper Basin Lake Management Units					
LMU K-H-C	S65H	0.32	0.99	0.19	0.99
LMU K-H-C	S61T	0.73	0.92	0.54	0.94
LMU K-H-C	S63AT	0.85	0.90	0.67	0.92
LMU Toho	S61H	0.17	0.98	0.34	0.94
LMU Toho	S59T	0.73	0.85	0.78	0.87
LMU Etoho	S59H	0.15	0.99	0.13	0.99
LMU Etoho	S62T	0.29	0.97	0.29	0.97
LMU Hart	S62H	0.10	0.99	0.11	0.98
LMU Hart	S57T	0.11	0.99	0.11	0.98
LMU Myrtle	S57H	0.15	0.99	0.18	0.98
LMU Myrtle	S58T	0.17	0.99	0.19	0.97
LMU Alligator	S58H	0.24	0.95	0.37	0.91
LMU Alligator	S60H	0.38	0.87	0.46	0.83
LMU Gentry	S60T	0.35	0.87	0.49	0.80
LMU Gentry	S63H	0.29	0.90	0.47	0.81
LMU s63a	S63T	0.18	0.94	0.18	0.95
LMU s63a	S63AH	0.14	0.97	0.13	0.98
Stages in Lower Basin Lake Management Units					
Pool A	S65T	1.58	0.70	1.31	0.74
Pool A	S65AH	1.68	0.59	1.42	0.63
Pool B	S65AT	3.01	0.83	2.31	0.87
Pool C	S65CH	0.11	0.84	0.11	0.98
Pool D	S65CT	0.11	0.82	0.08	0.91
Pool D	S65DH	0.11	0.89	0.11	0.99
Pool E	S65DT		0.83	0.46	0.93
Pool E	S65EH	0.12	0.86	0.11	0.98
Stages in Lower Basin's unmanaged watersheds					
D_Chandler	CYPRS	10.54	0.06	1.10	0.26
D_Chandler	CHAND1	0.73	0.70	0.64	0.75
Lake O	S65ET	0.04	1.00	0.004	0.99

Table 2-4: Surface Water Flow Statistics

Upstream WCU	Downstream WCU	Station	CE % Original	R(correlation) Original	CE % New PET	R (Correlation) New PET
Flows in Upper Basin Lake Management Units						
LMU Hart	LMU Etoho	S62Q	8	0.71	27	0.70
LMU Etoho	LMU Toho	S59Q	6	0.69	2	0.73
LMU Toho	LMU KHC	S61Q	9	0.86	25	0.86
LMU Alligator	LMU Gentry	S60Q	53	0.66	58	0.62
LMU Gentry	LMU S63A	S63Q	39	0.76	12	0.75
LMU KHC	POOLA	S65Q	10	0.82	11	0.84
Flows in Lower Basin Lake Management Units						
PoolA	PoolB	S65AQ	26	0.85	7	0.87
PoolC	PoolC	S65CQ	20	0.86	1	0.89
PoolD	PoolE	S65DQ	18	0.87	2	0.91
PoolE	Lake O	S65EQ	28	0.86	6	0.91

Groundwater

Groundwater statistics for both models were compared to determine if the calibration improved because of the new PET data. The comparison is shown in Table 2-5.

Table 2-5: Groundwater Elevation Statistics

MODEL AREA	Station	RMSE Original	R(correlation) Original	RMSE New PET	R(correlation) New PET
UKB SAS Calibration Wells for the 1000 x 1000 ft model					
UKB bc	BEELINE	1.57	0.57	1.60	0.63
UKB north	TAFT	0.70	0.81	0.72	0.76
UKB north	KISSFS	1.70	0.65	1.68	0.64
UKB north	REEDGW 10	0.85	0.78	0.83	0.81
UKB alligator	ALL 1	0.92	0.78	0.77	0.83
UKB east	CAST	0.97	0.50	1.32	0.51
UKB east	EXOT	0.87	0.79	0.99	0.79
UKB east	PINEISL	5.63	0.74	5.54	0.76
UKB central	WR 6	2.22	0.86	2.84	0.77
UKB central	WR 11	0.78	0.59	0.98	0.78
UKB east	CHAPMAN	1.49	0.57	1.35	0.61
UKB east	KENANS 1	1.40	0.81	1.55	0.82
LKB SAS Calibration Wells for the 1000 x 1000 ft model					
LKB east	ELMAX	1.57	0.68	1.51	0.71

LKB kr	TICKICL	2.88	0.32	2.50	0.35
LKB east	MAXCEY-N	3.62	0.33	3.22	0.34
LKB east	PEAVINE	3.17	0.48	2.93	0.48
LKB east	MAXCEY-S	2.50	0.52	2.22	0.52
LKB east	GRIFFITH	1.80	0.85	1.88	0.85

Groundwater elevations were also compared by preparing difference maps (original minus revised PET dataset) for the maximum, minimum and average groundwater elevations in the surficial aquifer. These maps are presented in Appendix B. In examining the maps, it was determined that the groundwater elevations increased in some areas and decreased in others.

3 CONCLUSIONS

The new set of PET data showed an improvement for most of the calibration (AFET verification) statistics. It is important to emphasize that the model was calibrated for the period 2001 through 2004 and that the PET data available for that period was more accurate than the PET available for the rest of the period. By replacing the verification PET data set by a set of comparable accuracy to that used in the calibration (01—04) it is expected that the verification statistics (94-98) get closer to the statistics obtained for the calibration period (01-04). The statistics for both surface and groundwater showed an improvement for most stations in the calibration with the revised PET.

In examining the water balance, it was noted that the revised PET resulted in an increase in evapotranspiration for the period 1994 to 1998, lesser overland storage, reduction in infiltration, and reduction of the infiltrated water that drained back to the river (drain to river). This reduction in drainage was 10 inches over a five year period (2 inches per year). Although differences in overland flow depth were minimal in most instances, in general, there was a decrease in overland flow depth. Surface water statistics for both models were compared and it was determined that the calibration improved because of the new PET data. Groundwater elevations were also compared by preparing difference maps for the maximum, minimum and average groundwater elevations in the surficial aquifer. The maps showed that groundwater elevations increased in some areas and decreased in others.

APPENDIX A

OVERLAND FLOW DEPTH COMPARISON

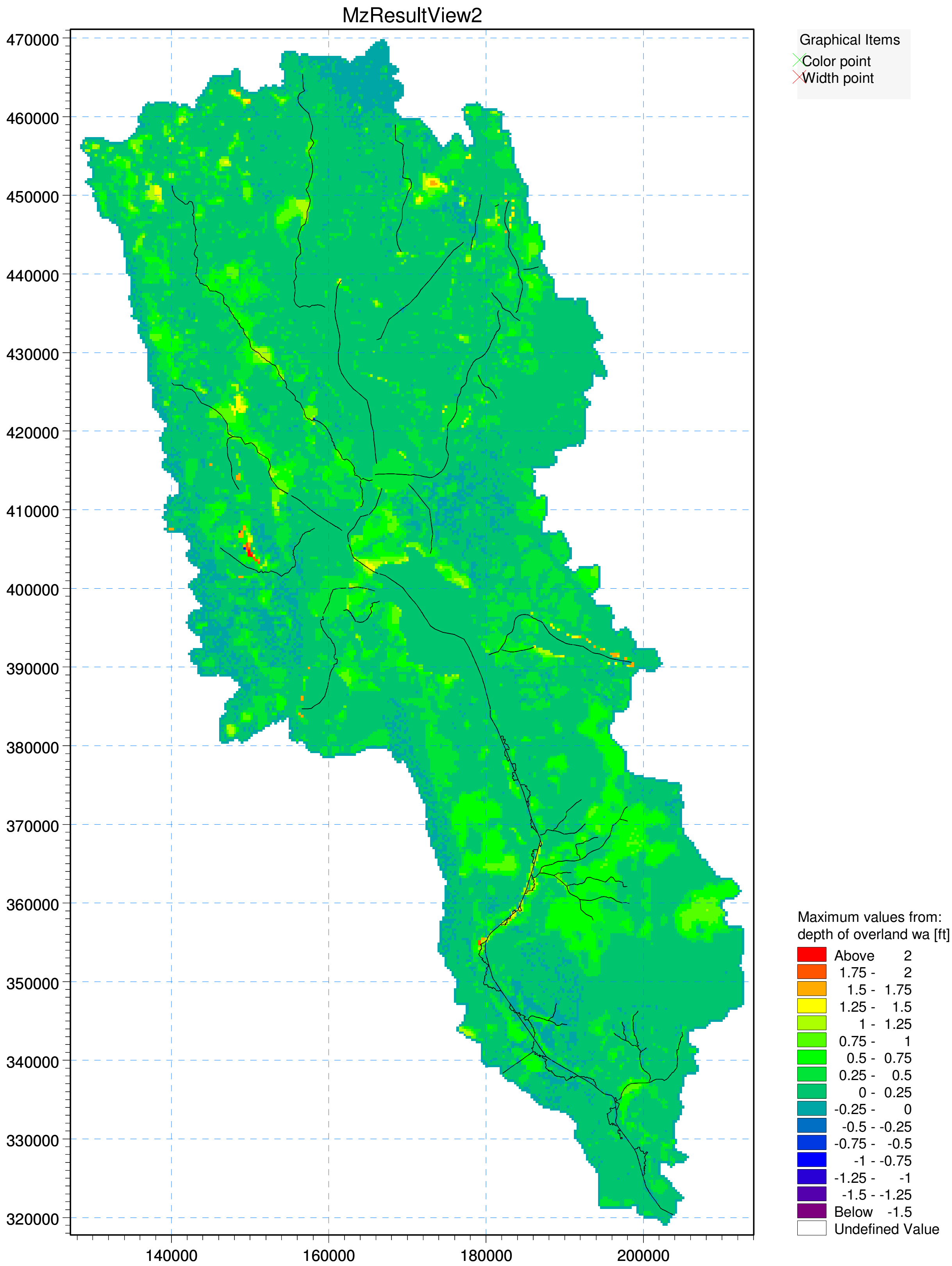

Figure A.1: Maximum overland flow depths difference for the 1996 wet period

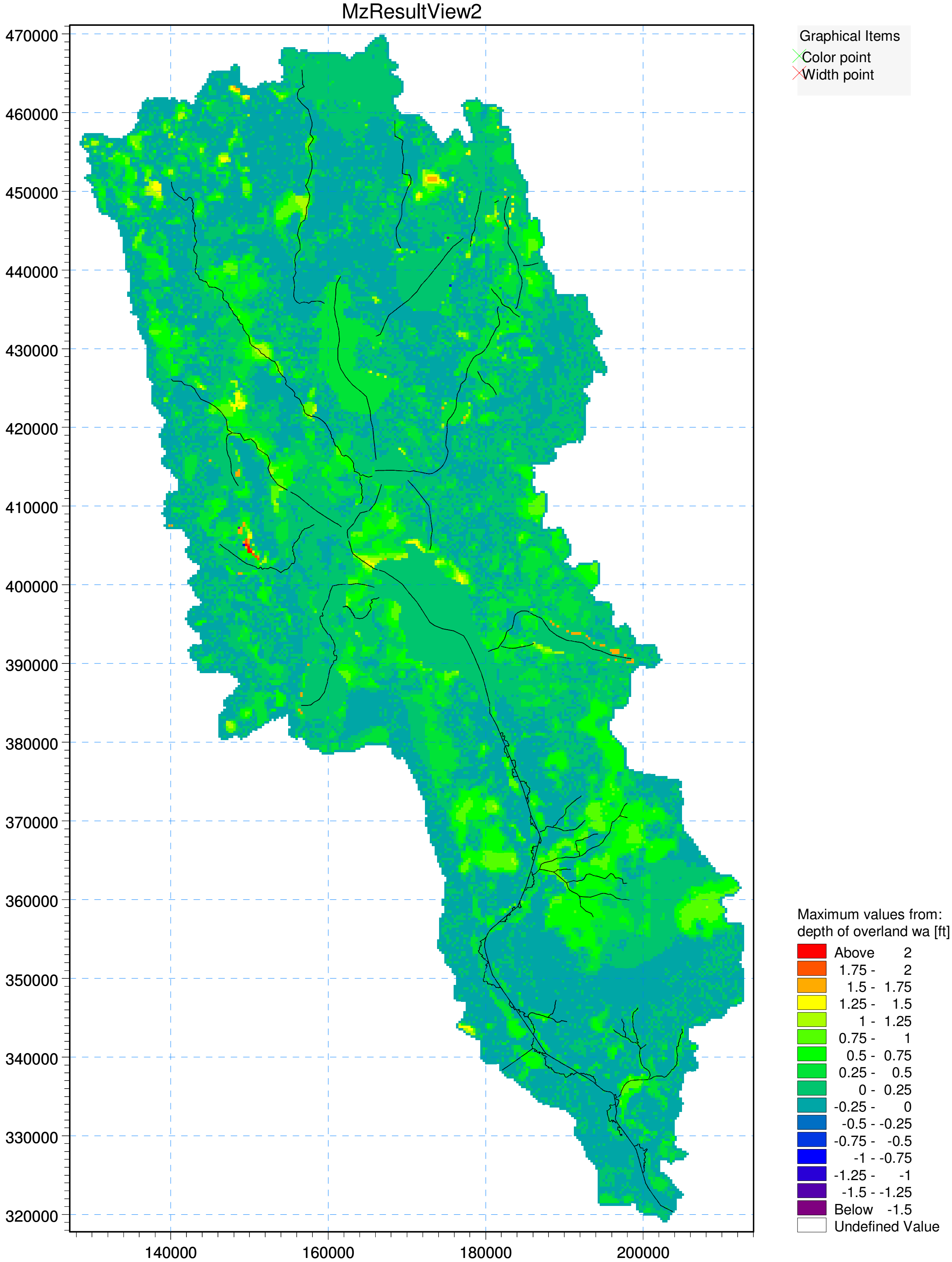

Figure A.2: Maximum overland flow depths difference for the 1996 to 1997 dry period

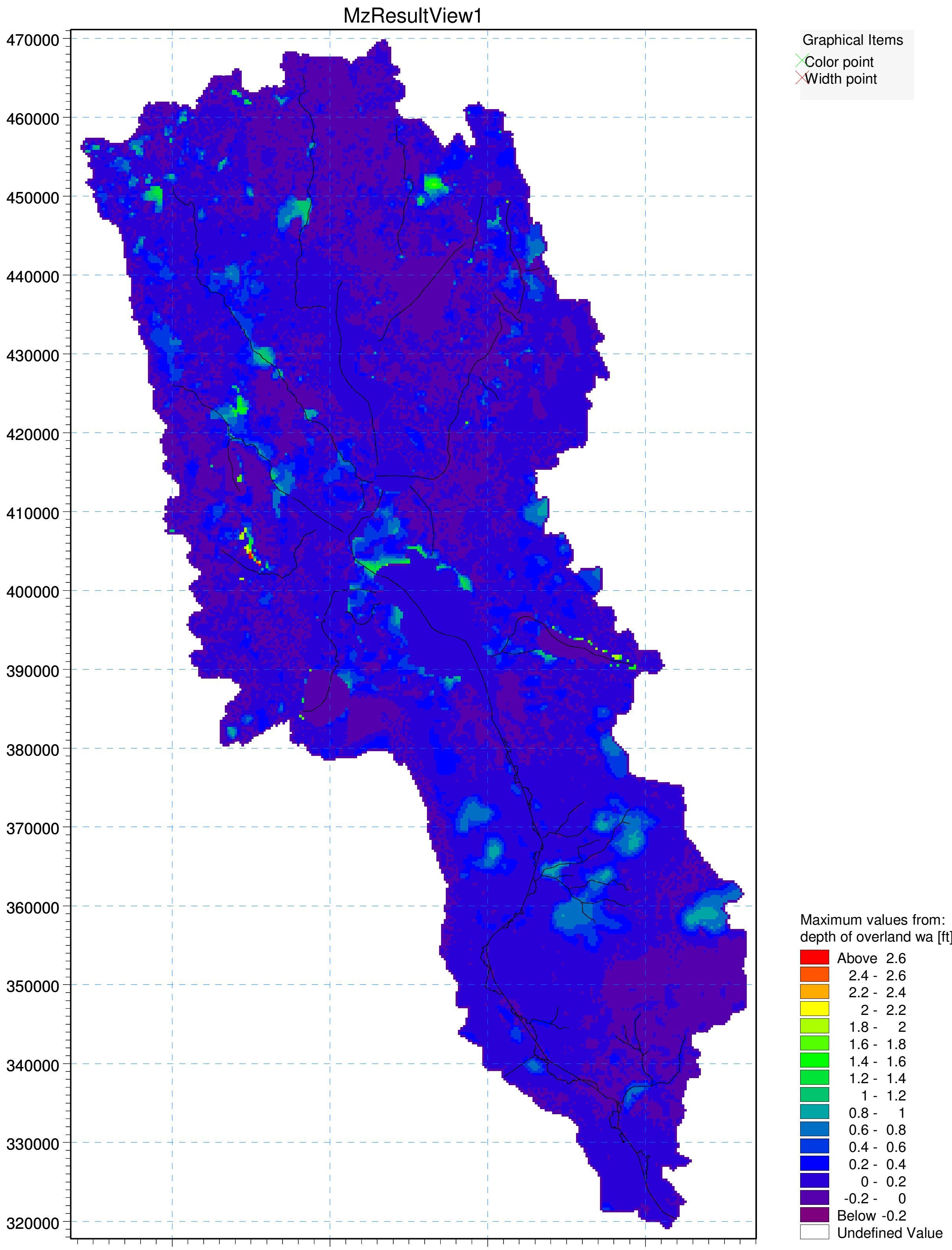

Figure A.3: Maximum overland flow depths difference for the 1997 wet period

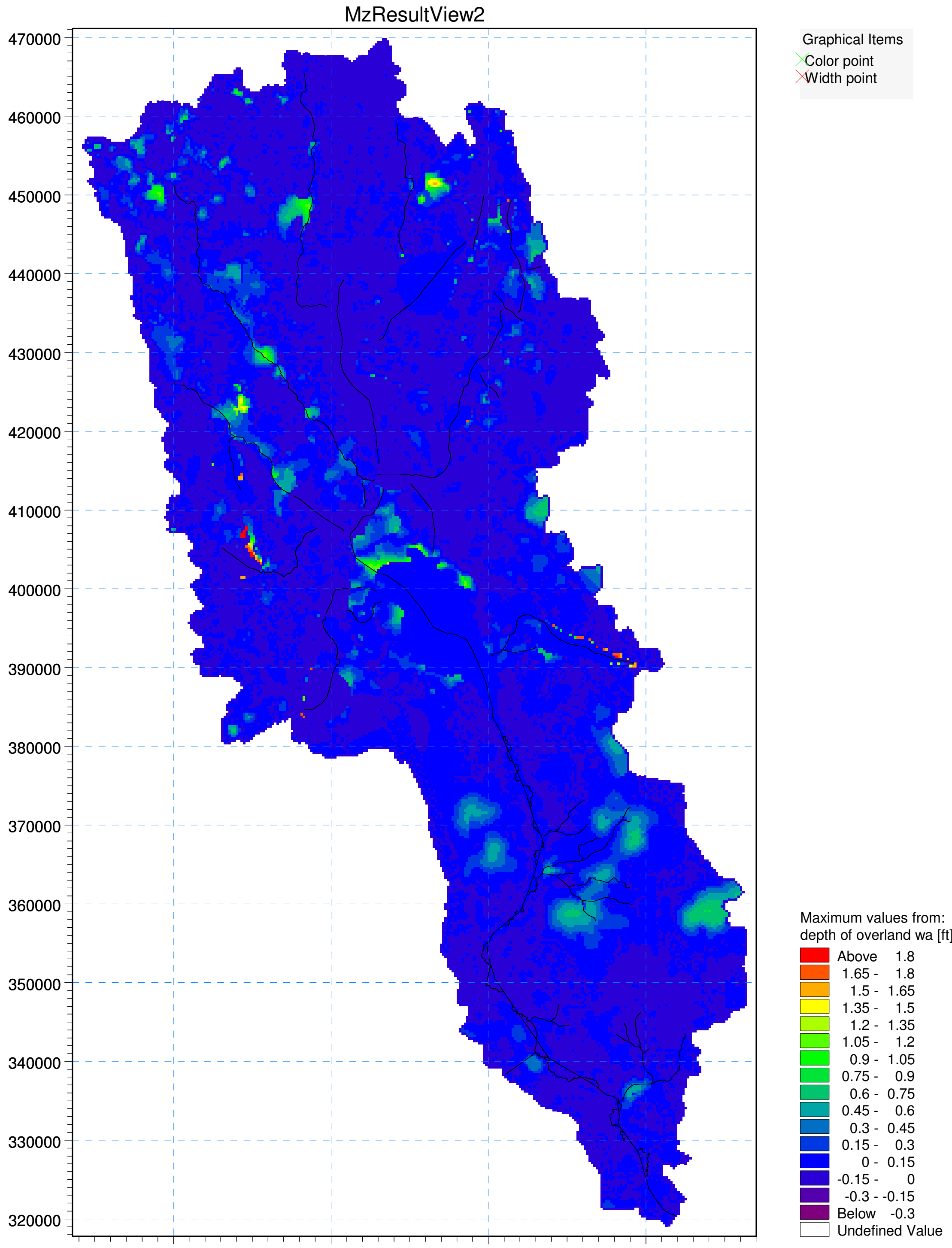

Figure A.4: Maximum overland flow depths difference for the 1997 to 1998 dry period

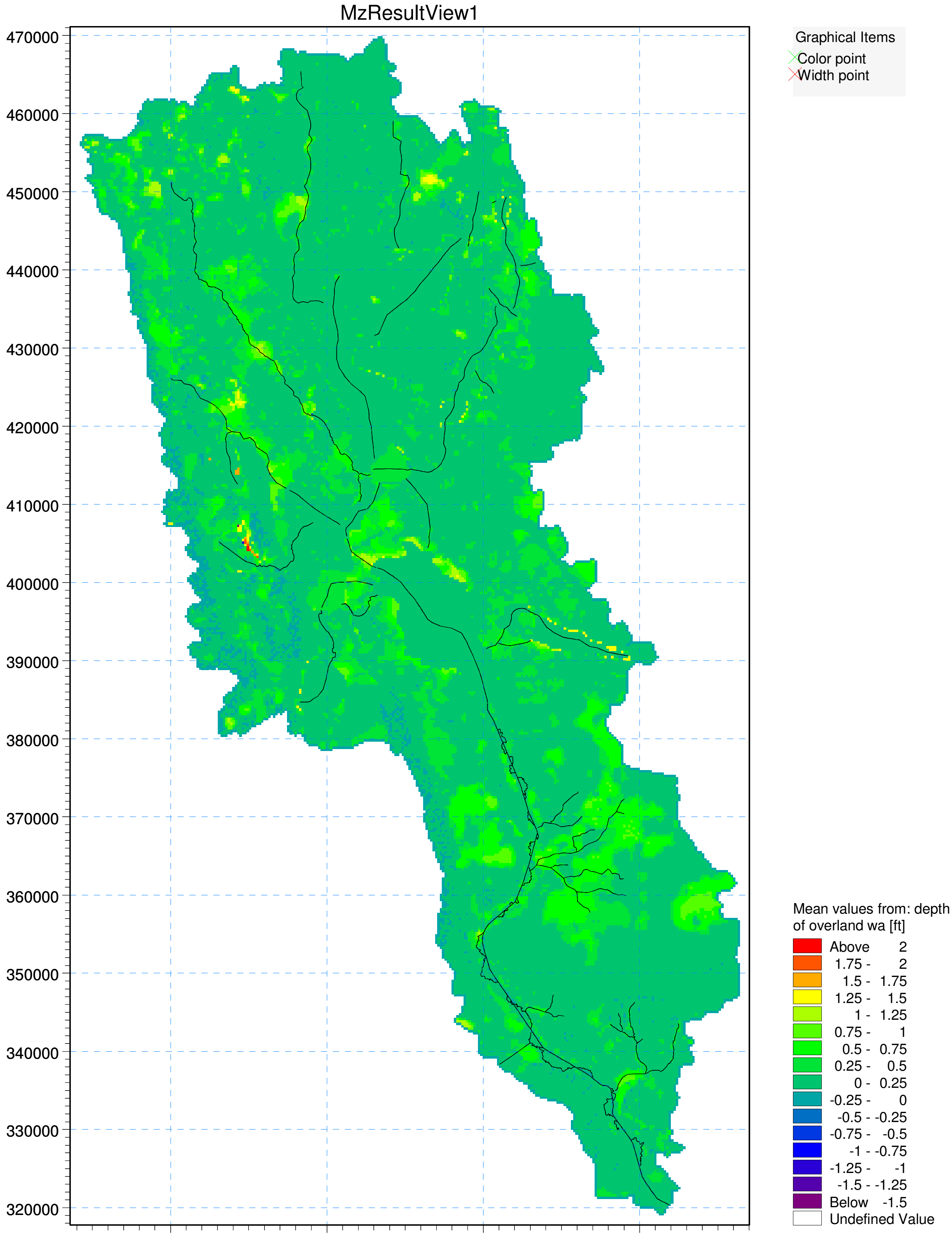

Figure A.5: Average overland flow depth difference for the 1996 wet period

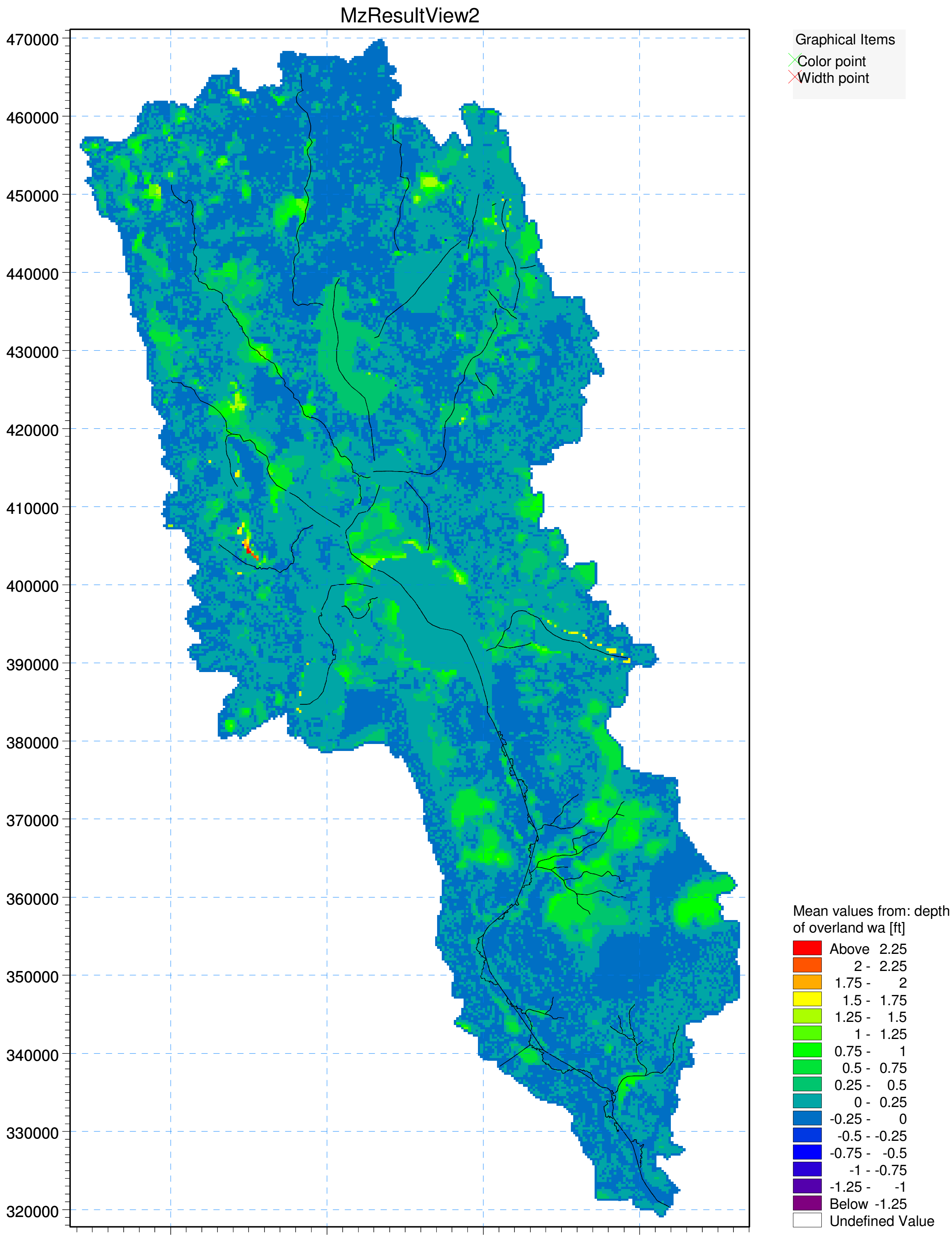

Figure A.6: Average overland flow depth difference for the 1996 to 1997 dry period

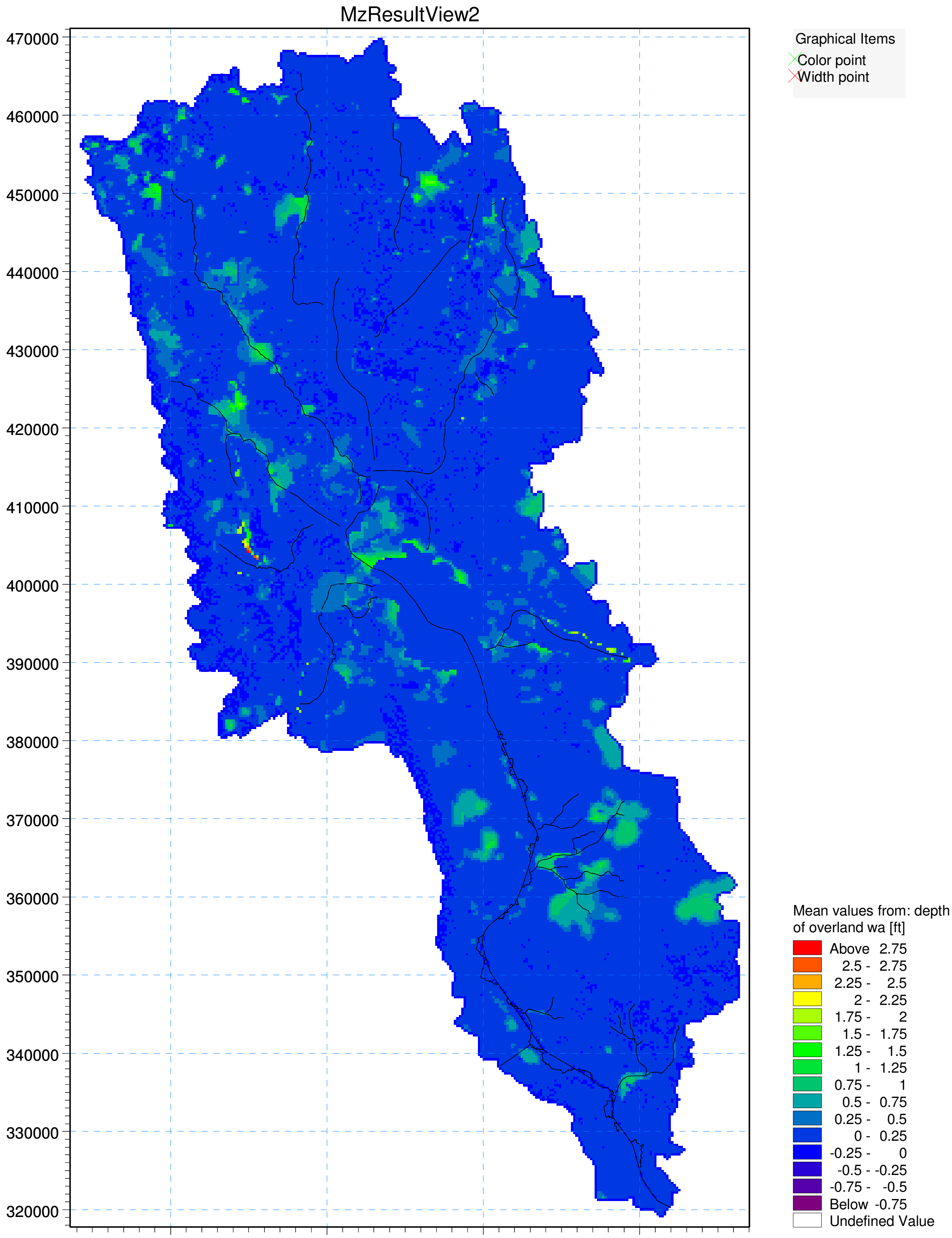

Figure A.7: Average overland flow depth difference for the 1997 wet period

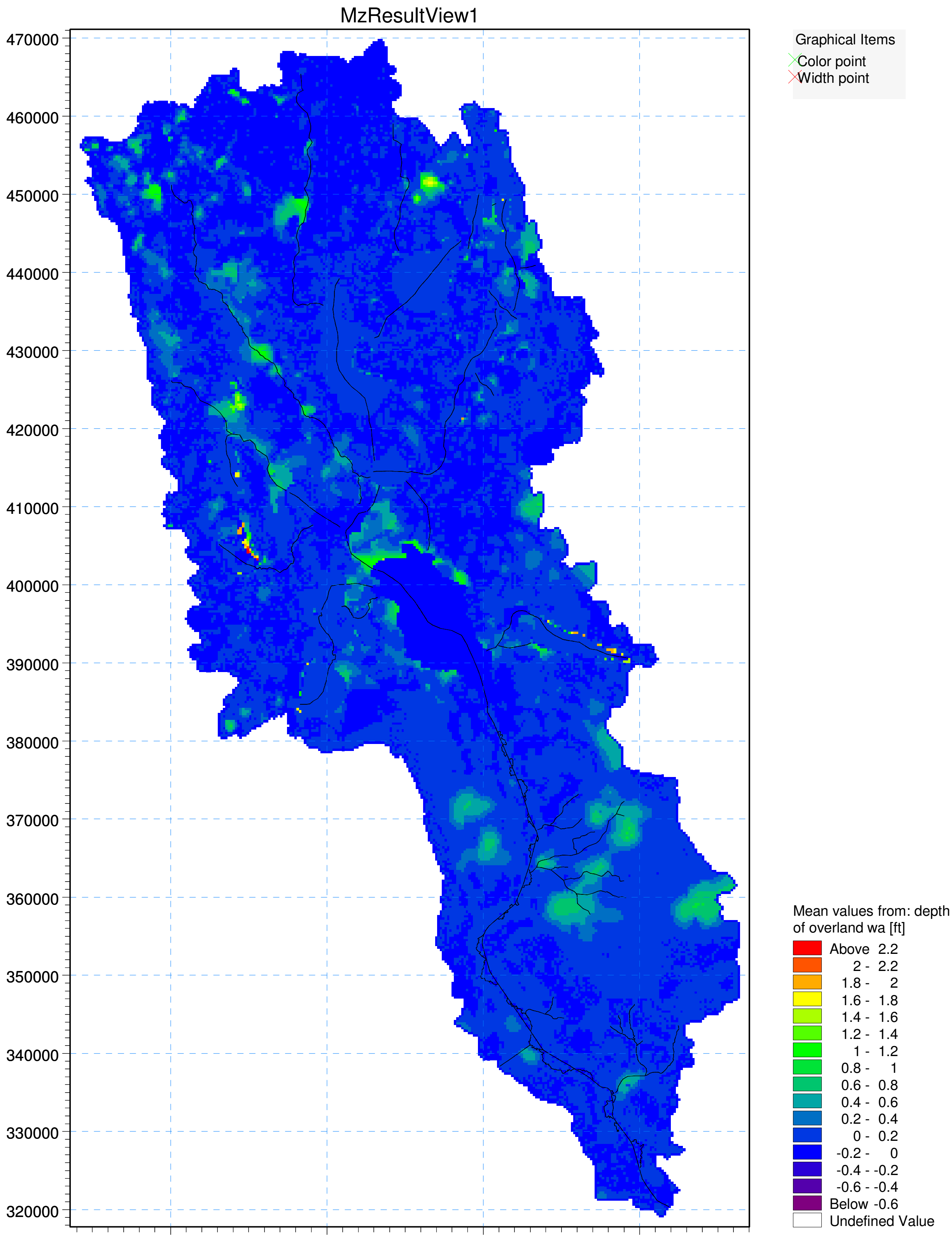

Figure A.8: Average overland flow depth difference for the 1997 to 1998 dry period

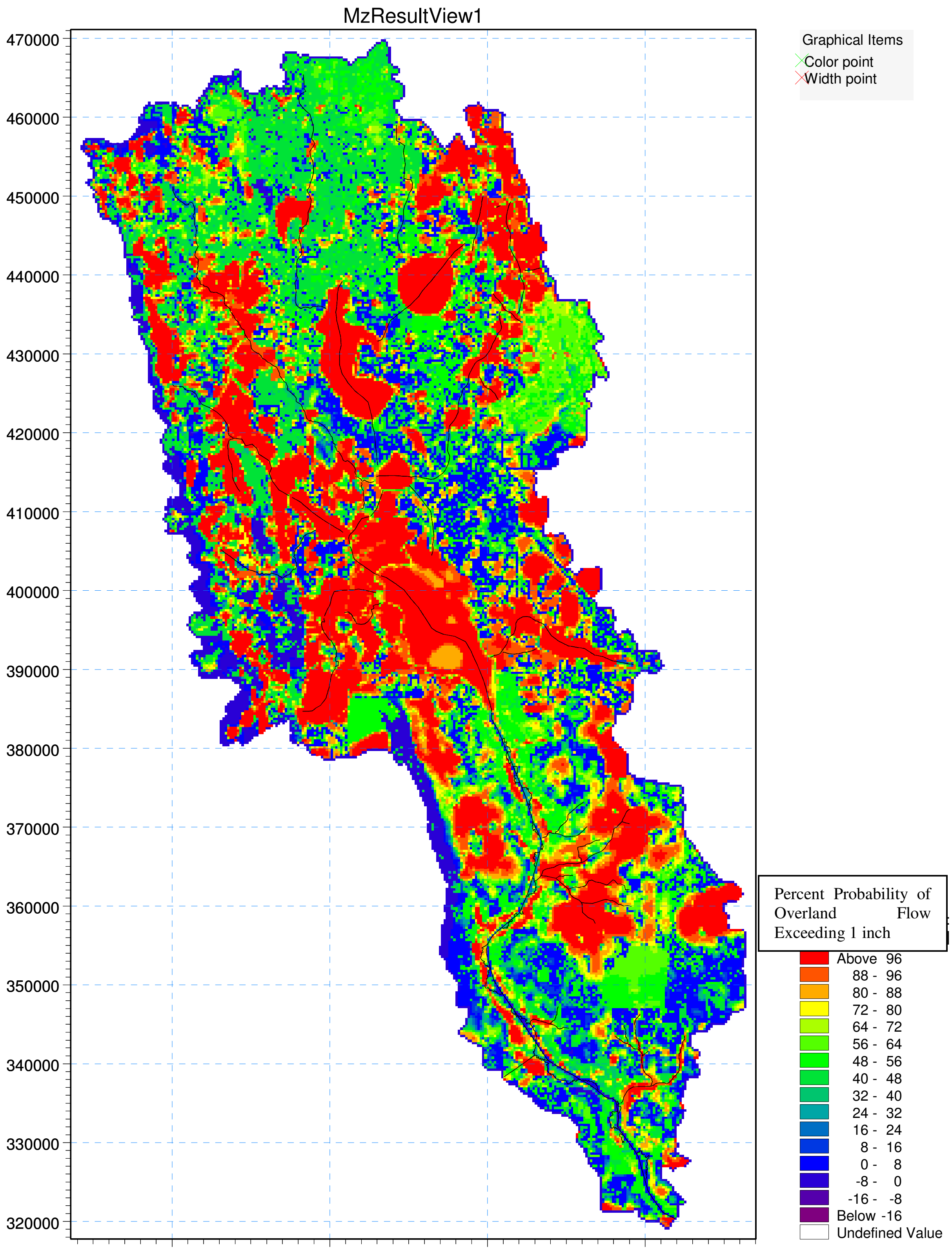

Figure A.9: Percent of time overland flow depths exceed 1 inch during the verification period (now calibration period)

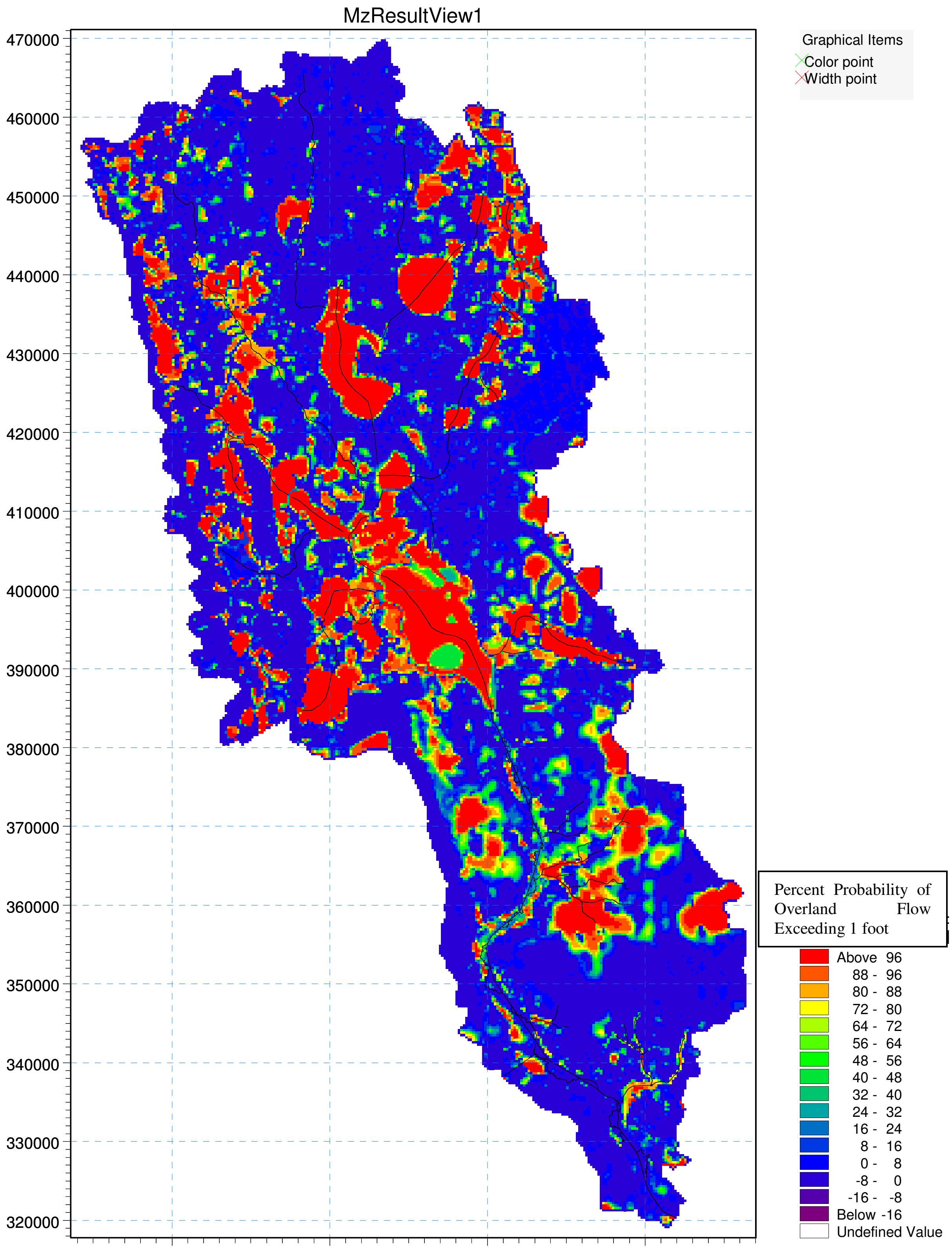

Figure A.10: Percent of time overland flow depths exceed 1 foot during the verification period (now calibration period)

APPENDIX B

GROUNDWATER DIFFERENCES

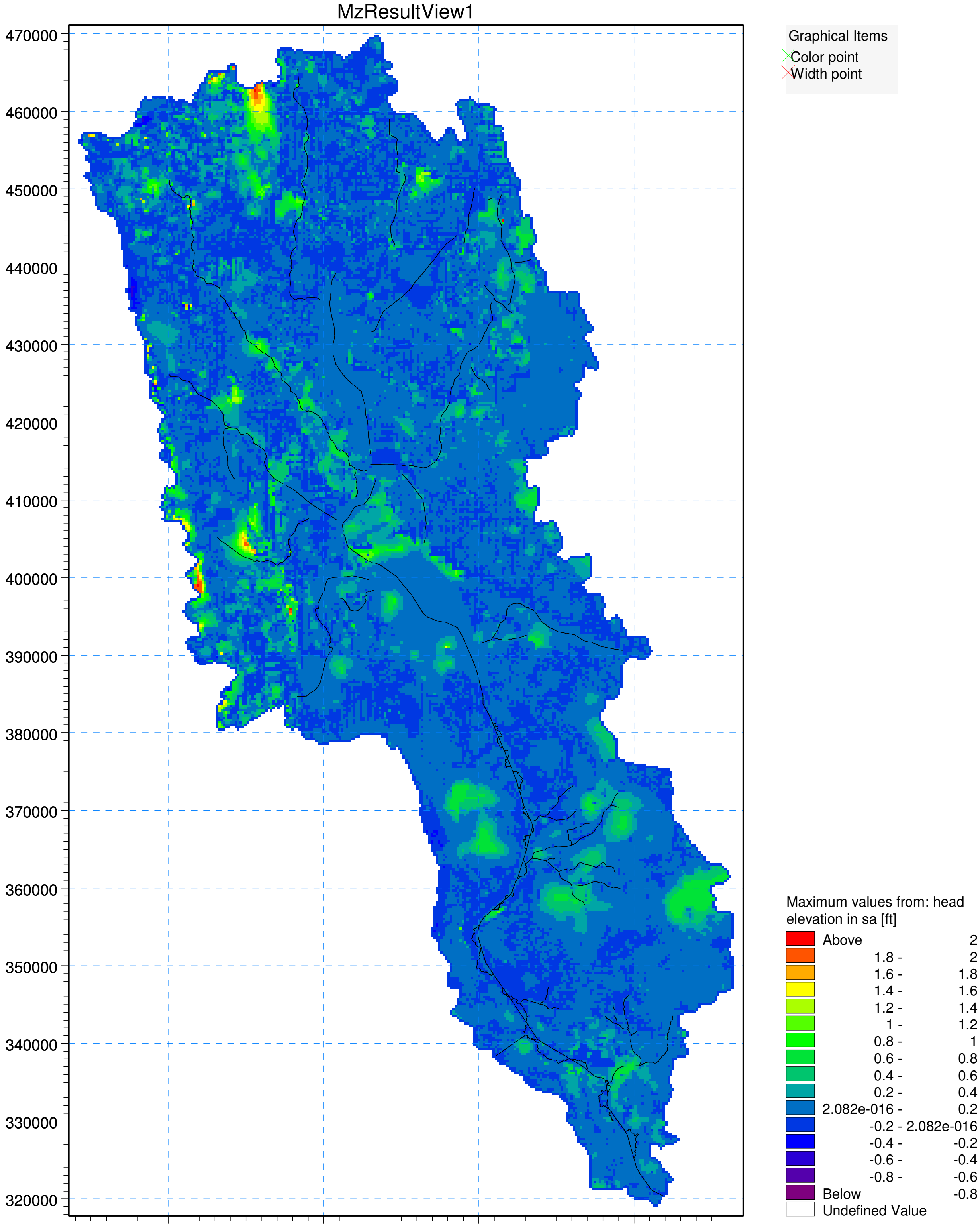

Figure B.1: Maximum Groundwater Elevation Difference

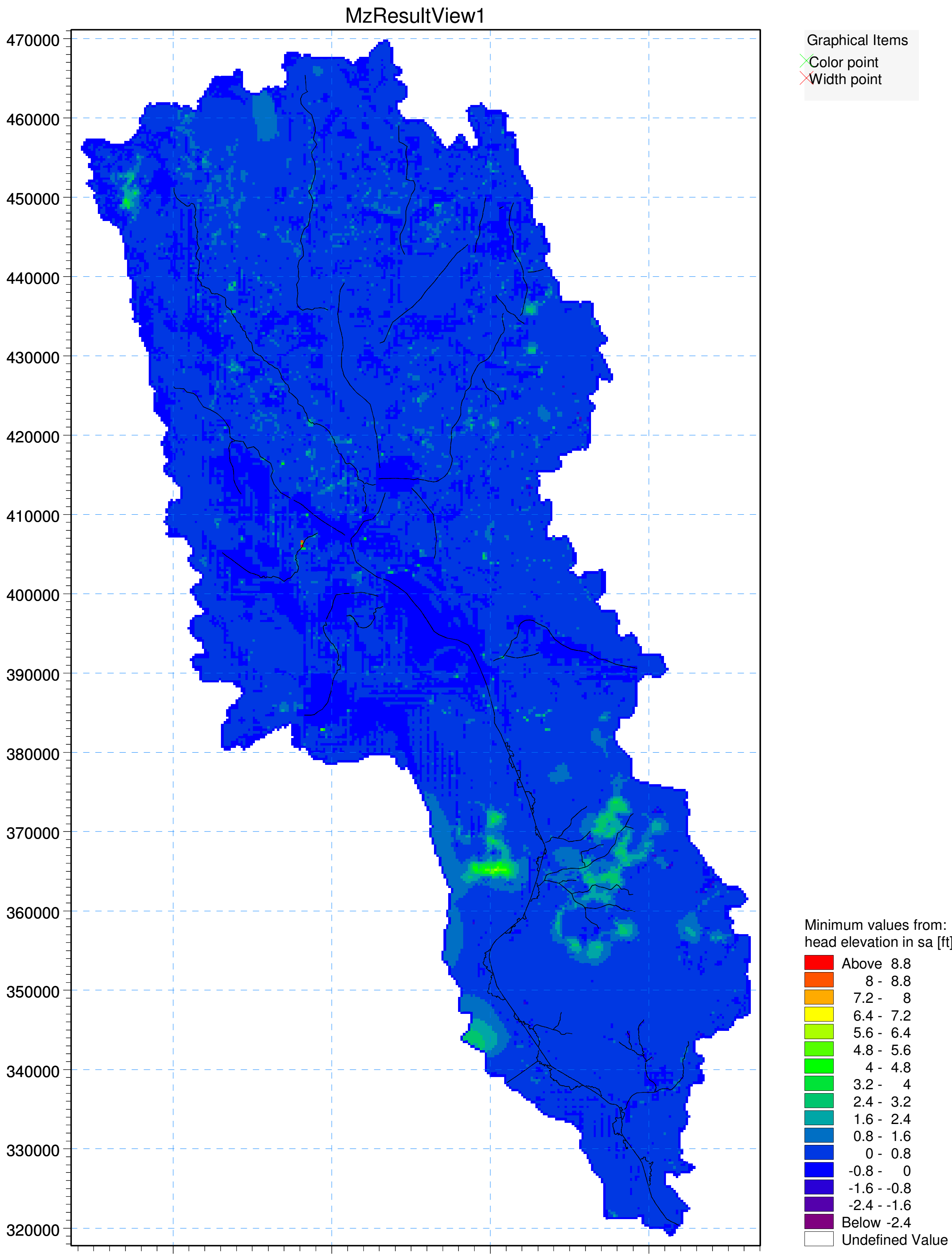

Figure B.2: Minimum Groundwater Elevation Difference

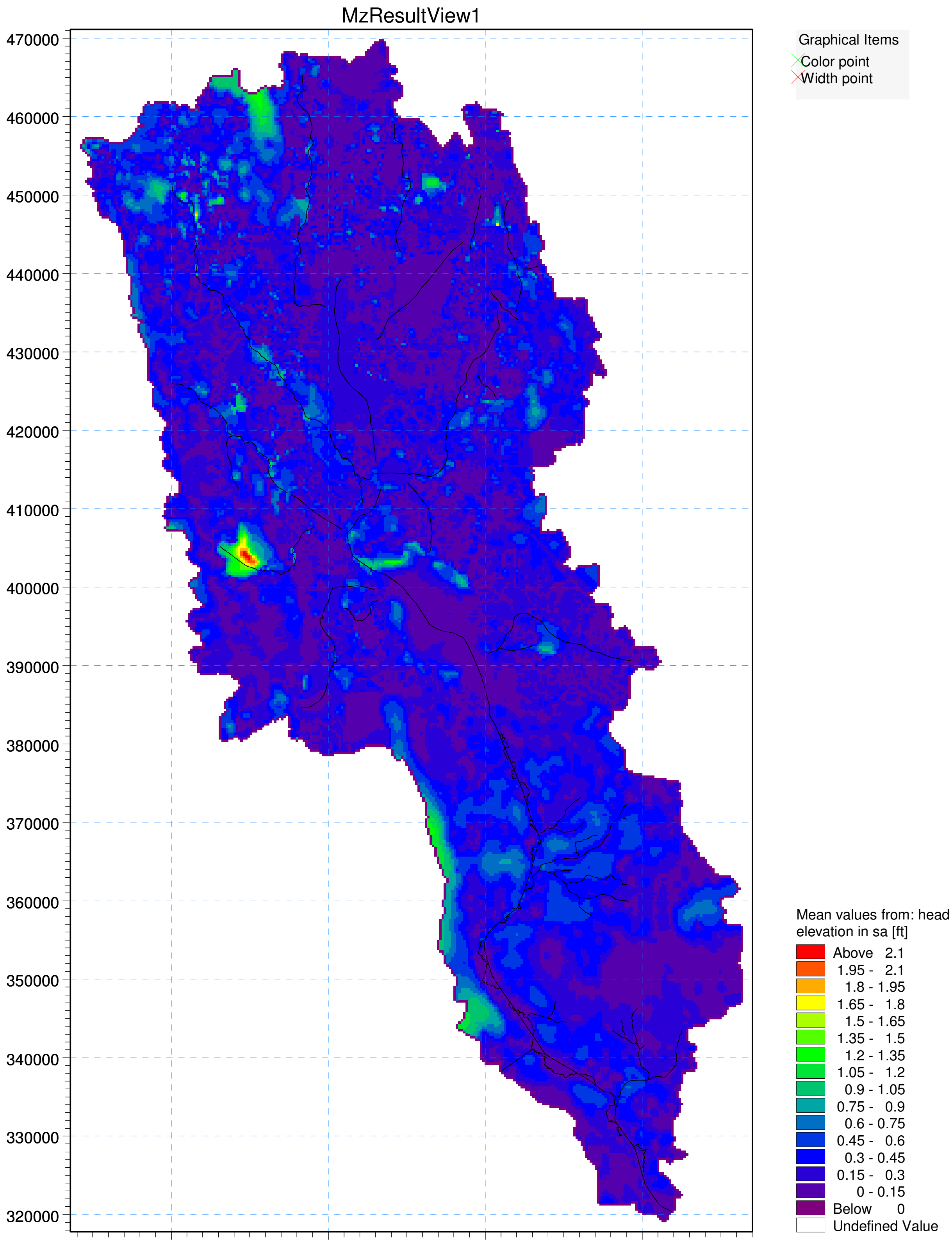

Figure B.3: Mean Groundwater Elevation Difference